

U.S. Patent Application Serial No. 10/507,066
Reply to Office Action of October 26, 2006

Amendments to the Specification:

Please amend the second and third paragraphs of page 2 as follows:

Using microstrip technology for narrow bandpass filter design, the spacing between the resonators usually determines the amount of coupling between the resonators. As the spacing increases, the coupling decreases and, therefore, the bandwidth becomes narrower. For very-narrow band filters, the spacing between resonators can be quite substantial. Techniques have been developed in the prior art to reduce the required spacing. For example, in a lumped element type resonator environment (see Zhang, et al. U.S., Patent Application 08/706,974, which issued on August 20, 2002 as U.S. Patent No. 6,438,394, and Ye, U.S. Patent Application 09/699,783); and in a distributed element type resonator environment (see Tsuzuki, et. al., U.S. Provisional Application 60/298,339), all assigned to the assignee of the current invention. These techniques have been shown to be successful in effectively reducing the spacing between resonators for very-narrow band filters in the respective environments. However, the techniques may not be effective (using the same structure), when the required bandwidth of the filter becomes large. Where a broader bandwidth is desired, closer spacing between resonators is required. In some cases, the spacing may become too small from manufacturability point of view, i.e., lithography, sensitivity, yield, etc.

It is also known that to reach higher filter rejection performance while maintaining a minimal number of resonators, couplings between non-adjacent resonators can be applied to realize transmission zeros. For example, see MICROSTRIP CROSS-COUPLING CONTROL APPARATUS AND METHOD, filed April 2, 1999, and receiving Serial No. 09/285350, which issued on March 4, 2003 as U.S. Patent No. 6,529,750, which application is commonly assigned to the assignee of the present application. Such application being incorporated herein and made a part hereof by reference. These transmission zeros can be placed at strategic locations to achieve optimal filter performance. Besides actual cross coupling value, the precise transmission zero location depends on the phase of these cross couplings, i.e., whether it is positive cross coupling or negative cross coupling. Therefore, cross coupling can be utilized to improve filter performance.

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Please amend page 4, line 8 as follows:

MgO, LaAlO₃, Al₂O₃, Al₂O₃ or YSZ.

Please amend page 5, line 1 to line 6 as follows:

adjacent the first resonator, S2b is the distance between the coupling strip and the second resonator, and L2b is the length of the coupling strip which lies adjacent the second resonator, the primary coupling $F1F1$, where F1 is a function of S1, and S1 is defined as the distance between the first resonator and the second resonator, wherein the total coupling between the first resonator and the second resonator, F, is defined by:

$$F = F1(S1) + F2(S2a, S2b, L2a, L2b).$$

Please amend the paragraph beginning at page 5, line 23 as follows:

Figures ~~1-a~~ 1a, ~~1-b~~ 1b and ~~1-c~~ 1c show three different conventional microstrip filter sections wherein the coupling between the two resonators is determined by the gap size "S".

Please amend the heading at page 6, line 6 as follows:

Detailed Description~~Detailed Description of the Preferred Embodiments~~

Please amend the paragraph beginning at page 6, line 26 as follows:

Turning first to Figures ~~1-a~~ 1a, ~~1-b~~ 1b, and ~~1-c~~ 1c, these figures generally illustrate conventional microstrip filter sections wherein the coupling between the two resonators (e.g., Resonator 1, Resonator 2) is determined by the gap size "S". By varying the gap size "S", the coupling increases or decreases and thereby affects the bandwidth. Figure 2 also illustrates a prior art microstrip filter section. In this figure, the coupling between the two resonators is also

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determined by the gap size "S". However, the coupling in Figure 2 differs from the couplings in ~~Figure 1~~ Figures 1a, 1b, 1c since, for the same gap size "S", the amount of coupling between the two resonators can be effectively reduced depending on the value of the series capacitor realized through the long, narrow finger interdigital capacitor form.

Please amend page 7, line 2 as follows:

controlled by gap size ~~S1~~ S1, is the primary coupling. The second part of the coupling,

Please amend page 7, the second paragraph as follows:

Figure 4 illustrates an alternative embodiment in which adjustments of S1 and/or the gaps S2a, S2b and lengths L2a, L2b (similar to S2 and L as in Figure 3) do not affect resonator length (and thereby the resonating frequency). The first and second resonators are identified as 20 and 21 respectively. Similar to Figure 3, the coupling between the two resonators 20, 21 is comprised of two parts. The first part, the primary coupling, is controlled by S1, the same as the one in Figure 3. However, the second part, the secondary coupling, is achieved through a coupling strip 23. By adjusting the gaps S2a, S2b and lengths L2a and L2b, the amount of secondary coupling can change within a wide range without affecting physical structure of both resonators.

Please amend page 8, line 31 to line 35 as follows:

Turning to Figures 5a, 5b, and 5c, a number of variations of resonators and a coupling strip utilized to generate the secondary coupling are shown. In Figure 5a, resonator ~~S1~~ S1 is adjacent resonator 52. The spacing S1 between resonators ~~S1~~ S1, S2 is identified in Fig. ~~5a~~ 5a and is a fixed spacing. Coupling strip 53 provides secondary coupling ~~S2~~ as discussed in connection with Fig. 4 (e.g., S2a, S2b, L2a and L2b).

Please amend the paragraph beginning at page 9, line 23 as follows:

Figure 6, a 6-pole filter constructed including the principles of the present invention is shown. The cross coupling strip 61 between resonator 1 to resonator 3 and the cross coupling

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strip 62 between resonator 4 to resonator 6 are of similar type. However, due to different couplings between resonator 2 to resonator 3 from cross coupling strip 63, and between resonator 4 to resonator 5 from cross coupling strip 64, the actual cross couplings from 61 and 62 have opposite signs: one is positive and other is negative. As shown in Figure 7, transmission zero 71 is achieved by negative cross coupling between resonators 1 and 3 from 61 and 63 in Fig. 6, while transmission zero 72 is achieved by positive cross coupling between resonators 4 and 6 from 62 and 64 in Fig. 6.